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Youth with Autism Spectrum Disorder Comprehend Lexicalized and Novel Primary Conceptual Metaphors

Eric L. Olofson[1], Drew Casey[1], Olufemi A. Oluyedun[1], Jo Van Herwegen[2], Adam Becerra[1], Gabriella Rundblad[3]

(1) Wabash College, 301 W Wabash Ave, Crawfordsville, IN 47933, USA
(2) Kingston University, Penrhyn Road, Kingston upon Thames, Surrey KT1 2EE, UK
(3) King's College London, FWB – WBW, Waterloo Road, London SE1 9NH, UK

Abstract

Individuals with autism spectrum disorder (ASD) have difficulty comprehending metaphors. However, no study to date has examined whether or not they understand conceptual metaphors (i.e. mappings between conceptual structures), which could be the building blocks of metaphoric thinking and understanding. We investigated whether 13 participants with ASD (age 7;03 to 22;03) and 13 age-matched typically developing (TD) controls could comprehend lexicalized conceptual metaphors (e.g., *Susan is a warm person*) and novel ones (e.g., *Susan is a toasty person*). Individuals with ASD performed at greater than chance levels on both metaphor types, although their performance was lower than TD participants. We discuss the theoretical relevance of these findings and educational implications.

Keywords: Autism; metaphor; conceptual metaphor; language

Corresponding author: Eric Olofson, olofsone@wabash.edu, 1-765-361-6328 (phone), 1-765-361-6277 (fax)

Youth with Autism Spectrum Disorder Comprehend Lexicalized and Novel Primary Conceptual Metaphors

Metaphors, which are statements (e.g., *that lawyer is a shark*) that communicate something about a *target* concept (e.g., lawyers) by inviting a comparison to a *source* concept (e.g., sharks), are common in adult discourse (Lakoff & Johnson, 1980; Sardinha, 2008). Compared to typically developing (TD) individuals, those with autism spectrum disorder (ASD) have well-documented deficits in understanding nonliteral uses of language such as metaphors (Rundblad & Annaz, 2010a; Tager-Flusberg, 2003), as well as a variety of other linguistic forms (MacKay & Shaw, 2004). Researchers concerned about these deficits have attempted to improve metaphoric competence in individuals with ASD, but although one study had some success in improving understanding of commonly used metaphors (e.g., a *train of thought*), it had no effect on understanding of novel metaphors (Mashal & Kasirer, 2011). Although the extant literature has not found any kind of novel metaphor that individuals with ASD can reliably comprehend, the current study was designed to find nascent metaphoric competence in individuals with ASD that has remained uncovered by previous experiments. Specifically, the current study tested the ability of youths with ASD to comprehend primary conceptual metaphors (Lakoff & Johnson, 1980), which are metaphors in which content from a sensorimotor source concept is mapped onto an abstract target concept.

The difficulty individuals with ASD have in interpreting metaphor is not only likely to influence their communicative competence or their understanding of literature that, even when aimed at child audiences, is rife with metaphor (Colston & Kuiper, 2002); this difficulty extends to other academic pursuits, as well. Metaphor is, at its core, about comparing two concepts or domains, a process that bears marked similarities to analogical reasoning (Bowdle & Gentner, 2005; Gentner, 1988; Gentner, Bowdle, Wolff, & Boronat, 2001). Given the role of analogical reasoning in problem solving (Gick & Holyoak, 1980), it should come as little surprise that research on scientific reasoning in elementary school aged TD children has found that their spontaneously produced metaphors are closely related to learning in science class, which has implications for science education (Jakobson & Wickman, 2007). The importance of metaphor has not been lost on educators working with youth with ASD. In most states within the United States, including the one in which the current study was conducted, educators in public schools develop individualized education programs for children with ASD to meet core educational standards set for all children (Common Core State Standards Initiative, 2010) that call for the ability to understand metaphors by the fourth grade. Curricula developed for children with ASD have likewise singled out nonliteral language comprehension and are used in both the United States (e.g., The New England Center for Children, 2013) and the United Kingdom (e.g.,

North West Regional Special Educational Needs Partnership, Great Britain, Department for Education and Skills, 2004). Given this broad range of interest in metaphor, and the importance of metaphoric competence in teaching of new concepts in formal education settings, finding building blocks of metaphoric competence would be of interest not only to researchers working in psychology, linguistics, cognitive science, and philosophy, but also to educators and others who work with individuals with ASD.

After a brief overview of metaphor development in TD and ASD individuals, we discuss conceptual metaphor theory (Lakoff & Johnson, 1980; 1999), which provides clues about what kinds of metaphoric building blocks individuals with ASD may possess.

Overview of Metaphor Development

The ability to comprehend metaphors develops slowly over the first decade of life in TD individuals (see Winner, 1988, for a review). By three years of age, TD children are able to understand language that notes perceptual similarities between a visually presented stimulus, such as an upside-down mop, and an aurally presented metaphoric word, such as “flower” (Gottfried, 1997; Winner, McCarthy, & Gardner, 1980). Metaphors based on more complex mappings, such as those presented in stories that convey characters’ dispositions and actions, are still undergoing development at nine years of age (Reyna & Kiernan, 1995). Studies that have included participants across a wide age range provide even more compelling evidence for a linear development of metaphoric competence from early childhood through adulthood (Rundblad & Annaz, 2010b).

Unfortunately, explaining this development is difficult; the wide range of estimates regarding when metaphoric competence emerges is due, in part, to discrepancies in methodologies between the studies. The kinds of source-to-target mappings represented by the stimuli have varied widely between studies, and exactly what counts as a metaphor has not always been theoretically motivated (but see the work of Özçalışkan, 2005; and colleagues, Stites & Özçalışkan, 2013a; 2013b, discussed below, for notable exceptions). This has resulted in a wide variety of stimuli being used in research on the development of metaphoric competence, and this inconsistency has resulted in a wide variety of cognitive abilities being classified as metaphoric processing, from mappings based on perceptual similarity within a single domain (e.g., the shape of two objects) to mappings that involve cross-domain mappings that are unrelated to perceptual similarity (e.g., saying "the prison guard was a rock," Winner, Rosenstiel, & Gardner, 1976). Although it is possible that both kinds of mappings reflect common processing mechanisms, this question has not been the focus of research within developmental psychology. To our knowledge, only one study has

explicitly investigated the development of comprehension of perceptual and non-perceptual metaphors over a wide age range; that study found no differences in the developmental trajectories of the two types of metaphors (Van Herwegen, Dimitriou, & Rundblad, 2013). While that study supports the predictive validity of the argument that both perceptual and non-perceptual metaphors are processed similarly, the study was not designed to test that hypothesis. More attention has been given to variables that influence children's success on metaphor comprehension tasks, such as how explicitly an utterance is marked as nonliteral (Gentner & Clement, 1988; Reynolds & Ortony, 1980; Siltanen, 1989; 1990) and the helpfulness of supportive contexts (Vosniadou, Ortony, Reynolds, & Wilson, 1984; Vosniadou, 1989). Nevertheless, those studies, like most within developmental psychology, were not designed to address the fundamental question of what *kinds* of metaphor are understood early in life.

Less is known about metaphoric competence in ASD, but the data are clear that individuals with ASD have deficits in nonliteral language comprehension and use (Tager-Flusberg, 2003). In particular, individuals with ASD have not been found to experience the same development of metaphor comprehension over the course of childhood and adolescence, remaining at floor performance into adolescence (Rundblad & Annaz, 2010a). One hypothesis for this poor performance is that the deficits in social cognitive abilities present in ASD, and in particular the understanding that others have mental states that can differ from one's own (Baron-Cohen, 1997; Baron-Cohen, 2000), lead to deficits in the ability to understand a speaker's communicative intention when using non-literal language. While some evidence exists for this explanation of the low metaphoric competence in ASD (Happé, 1993), other research has not replicated the association between performance on social cognition tasks and metaphor competence (Norbury, 2005; Rundblad & Annaz, 2010a). Norbury found that semantic ability, not social cognitive abilities, predicted metaphoric competence. Mashal and Kasirer (2011) found a similar effect in an experimental study in which individuals with ASD participated in training sessions during which they were provided with the necessary semantic information to understand lexicalized metaphors (i.e., metaphors in such common use that the metaphoric meaning has become lexicalized as part of the definition of the words involved) and novel metaphors. After training, individuals with ASD improved on a new set of lexicalized metaphors, but there was no improvement on novel metaphors (unlike TD individuals and those with learning disabilities, who also improved on a new set of novel metaphors). This finding points to semantic ability as a key factor in the interpretation of lexicalized metaphors. Similar findings are present in the literature on Asperger's syndrome (AS), a type of ASD that does not involve general language delay[1]. One study suggests that individuals with AS struggle with the novelty of the

metaphoric expressions (i.e., the fact that this may have been participants' first exposure to the phrase or comparison invited by the metaphor) rather than metaphoricity, per se (Gunter, Ghaziuddin, & Ellis, 2002). In other words, in the novel metaphor used in that study, *the old man had a head full of dead leaves*, the source of difficulty experienced by individuals with AS may have been the fact that they had never heard a comparison between mental experience and foliage before and were thus confused, not the fact that they were unable to think of how one concept could be understood vis-à-vis another concept. Another recent study suggests that individuals with AS have a more difficult time using context to interpret metaphors, but, like TD individuals, they rely on their semantic knowledge and ability to identify appropriate word meanings when trying to understand metaphor (Giora, Gazal, Goldstein, Fein, & Stringaris, 2012). Despite these positive findings in AS (but see Dennis, Lazenby, & Lockyer, 2001; and Gold & Faust, 2010), the empirical literature on metaphor interpretation in ASD is dominated by findings of severely reduced ability (Dennis et al., 2001; Happé, 1993; Jolliffe & Baron-Cohen, 1999; MacKay & Shaw, 2004; Mashal & Kasirer, 2011; Rundblad & Annaz, 2010a). As with the TD literature, however, the lack of a theoretically motivated metaphor typology may be limiting researchers' abilities to find building blocks of metaphoric competence. However, conceptual metaphor theory (Lakoff & Johnson, 1980) may provide clues to those building blocks.

Conceptual Metaphor Theory

Since 1980, scholarship on metaphor has been heavily influenced by conceptual metaphor theory (CMT, Lakoff & Johnson, 1980; 1999), which argues that we understand many abstract concepts like time, love, and difficulty by drawing on our embodied experience with more concrete entities like moving objects, journeys, and physical weight (Gibbs, Lima, & Francozo, 2004; Grady, 1999; Kövecses, 1990). At first glance, CMT appears unrelated to the developmental literature on metaphor comprehension, which has focused on traditional[2] metaphors. At its core, it is an account of how abstract concepts are structured rather than of linguistic expressions. Linguistic metaphors are simply indicators of underlying mappings between concepts. According to CMT, cross-domain mappings from concrete source concepts to more abstract target concepts, called conceptual metaphors, underlie our ability to comprehend metaphorical statements such as "*this semester has really flown by*," "*our relationship isn't going anywhere*," and "*the weight of this deadline is dragging me down*." This emphasis on conceptual mappings contrasts with the Standard Pragmatic Model (Grice, 1975; Searle, 1979) that argues metaphors are literally false statements, the meaning of which are computed in on-line discourse contexts. By explaining metaphor

comprehension vis-à-vis conceptual structure rather than discourse skill, CMT does not predict that individuals with deficits in ability to interpret discourse would necessarily show deficits in comprehension of conceptual metaphors. As long as individuals have the ability to form these underlying mappings and activate them in discourse contexts, CMT predicts successful metaphor comprehension.

Grady and colleagues have outlined a typology of conceptual metaphor based on the manner in which the metaphoric mapping is created (1997a; 1999; 2005; Grady & Johnson, 2000). On this view, *primary* conceptual metaphors are those motivated by correlations between the source and target domains in early childhood (Grady, 1999). Consider the primary conceptual metaphor is *MORE IS UP*[3]. Grady and Johnson (Grady, 1997a; Grady & Johnson, 2000) argue that children's experiences of increases in amount are conflated with a visual representation of increases in verticality (e.g., when liquid is added to a container the fluid level rises). These simultaneous experiences of concrete source domains (e.g., sight of increased verticality) and abstract target domains (e.g., ideas of quantity) are called primary scenes. After repeated experiences of primary scenes, children begin to think of the more abstract concept vis-à-vis the more concrete concept. Ultimately, the source concept provides a basis on which to structure the target concept, so that when children think about abstract quantities, such as how much trouble they will be in for misbehaving, they automatically activate the concrete source concept. This is important in the context of individuals with ASD because it predicts that as long as children have these experiences and sufficient linguistic ability to interpret conversations about the abstract target domains, they ought to be able to interpret metaphors that rely on the mapping (e.g., "*if I steal that cookie, I'll be in a heap of trouble.*"), even if the linguistic formulation of that conceptual mapping is a novel one. In other words, if children with ASD are likely to have the building blocks of metaphoric competence, then, according to CMT, they will be primary conceptual metaphors.

Psycholinguistic research on adult TD populations has supported CMT (see Gibbs, 2011; Gibbs et al., 2004; and Lakoff & Johnson, 1999, for reviews; but for contradictory reviews see Murphy, 1996; Vervaeke & Kennedy, 1996; 2004). Despite the research on adult populations, empirical work on the development of conceptual metaphor comprehension has been rare. However, recent research on children's comprehension of conceptual metaphors for spatial motion (Özçalışkan, 2005) has found that children as young as four years of age can comprehend both idiomatic metaphors for the movement of time (e.g., *time flies*) and non-idiomatic metaphors (e.g., *time drips*). Further support for CMT comes from additional findings that the development of comprehension of time metaphors is predicted by conceptual knowledge and not verbal ability (Stites & Özçalışkan, 2013b) and is best

explained by the growth of sensorimotor experience over time (Stites & Özçalışkan, 2013a). These findings suggest that comprehending conceptual metaphors should develop as long as there is an understanding of the linguistic input and the concepts involved, and the ability form cross-domain mappings between them.

Although CMT predicts comprehension of conceptual metaphors in individuals with ASD, research suggests that the ability to form cross-domain mappings between sensorimotor concepts and abstract concepts is impaired in ASD (Eigsti, 2013), which suggests that the development of metaphoric competence may also be affected. In order for cognition to be embodied (i.e., for sensorimotor experiences to influence abstract cognition), the system of neural networks connecting brain areas that process sensorimotor experiences with brain areas that process abstract conceptual information needs to develop, and this system is known to develop and function differently in individuals with ASD (Belmonte et al., 2004). These differences in connectivity in ASD, such as those between the frontal and parietal areas (Just, Cherkassky, Keller, Kana, & Minshew, 2007), may overlap with the frontal-parietal networks believed to be critical in the process of forming cross-domain mappings that underlie conceptual metaphors (Gallese & Lakoff, 2005). Regardless of whether these connectivity differences are responsible for the differences in embodied cognition between ASD and TD individuals, those differences likely impact how individuals with ASD make sense of their experiences (De Jaegher, 2013) and consequently might impact how they interpret metaphors. This suggests caution in making a strong prediction that individuals with ASD will show a similar developmental progression as TD individuals in their understanding of conceptual metaphors.

The Current Study

The current study investigated the development of primary conceptual metaphor comprehension in TD and ASD individuals. In line with recent research on metaphor comprehension in ASD (Rundblad & Annaz, 2010a), we recruited participants across a wide age range in order to examine developments related to chronological age and verbal ability. In question was whether or not individuals with ASD demonstrated understanding of lexicalized and novel primary conceptual metaphors, thereby showing building blocks of metaphoric competence. If these building blocks are present, then individuals with ASD should show above-chance comprehension of both lexicalized and novel primary conceptual metaphors.

Research Question 1: What underlying factors (i.e., chronological age, verbal ability, or non-verbal mental age) predict metaphor comprehension? Grady's theory of primary conceptual metaphors (Grady, 1999; 2005; Grady & Johnson, 2000) predicts that these mappings are in place early in life; therefore, given the focus on school-aged

youths in the current study, there should be no effect of chronological age because all participants should perform well. However, given the deficits in embodied cognition in ASD (Eigsti, 2013) due, at least in part, to differences in neural connectivity (Belmonte et al., 2004), it may be the case that these mappings develop differently and/or more slowly. The lack of research on these particular conceptual mappings in ASD precludes a clear prediction.

Regarding verbal ability, CMT again predicts no effect; all participants capable of understanding the concepts and passing the task should perform well on both lexicalized and novel metaphors. Again, however, the deficits in embodied cognition in ASD may interfere with the development of additional, metaphoric meanings of words based on conceptual mappings.

Non-verbal mental age (NVMA) was included in the current study to confirm the cognitive profile expected in ASD. Prior research has not found a correlation between NVMA and metaphor comprehension (Rundblad & Annaz, 2010a), thus it was not included in hypothesis tests.

Research Question 2: Do TD youth understand lexicalized and novel primary conceptual metaphors equally well? CMT predicts that they will, and this prediction has been supported in the developmental literature (Özçalışkan, 2005; Stites & Özçalışkan, 2013b). However, given that the computerized task used in the current research has not yet been used to assess comprehension of conceptual metaphors, it is important to replicate these results.

Research Question 3: Do youths with ASD show similar patterns as TD youth? CMT predicts that, as long as TD and ASD individuals understand the concepts comprising the metaphors and are able to pass the task, they will not differ in their comprehension of either lexicalized or novel metaphors. This is a unique prediction that contradicts extant findings of poor metaphor comprehension in ASD, and in particular with regard to novel metaphors (Giora et al., 2012). Any differences in embodied cognition should not make the contrary prediction that comprehension of novel metaphors will be worse than comprehension of lexicalized metaphors; if any shortcomings in ASD youths compared to TD youths are due to differences in the ability to make conceptual mappings between sensorimotor and abstract concepts, these could similarly affect performance on lexicalized and novel metaphors.

Research Question 4: Regardless of group differences, do youth with ASD show above-chance levels of metaphor comprehension? CMT predicts that individuals will be above chance for both lexicalized and novel primary conceptual metaphors. The differences in embodied cognition do not necessarily predict that youth with ASD will fail to comprehend metaphors, just that they may lag behind their TD peers.

Although the current research was additionally motivated by an interest in whether or not comprehension of primary conceptual metaphors would be greater than that of traditional metaphors, the methodology was not designed to test that particular question. We will, however, return to that question in the discussion.

Method

Participants

Eighteen individuals with an ASD participated in the study. Participants were recruited from, and tested in, either mainstream public schools—the $ASD_{mainstream}$ group—or in a private educational center for youth with ASD—the ASD_{center} group—in both urban and rural settings in a Midwestern state in the USA. All parents reported a diagnosis of an ASD—including autistic disorder, high functioning autism (HFA), AS, and pervasive developmental disorder not otherwise specified (PDD-NOS)—by a physician or clinical psychologist. Participants with diagnoses of any ASD subtype from the DSM-IV (American Psychiatric Association, 2000) were included in the study because the DSM-5 (American Psychiatric Association, 2013a) abolished subtypes in the DSM-5 (American Psychiatric Association, 2013b) and meta-analytic data questions the validity of AS and HFA as valid subtypes of ASD (Witwer & Lecavalier, 2008; see also Mayes & Calhoun, 2003).

Participants in the $ASD_{mainstream}$ group were recruited from local schools via a letter sent by the agency that coordinates special education services for local school districts. These children generally spend one hour per day in special education classes and the rest of the day with their TD peers. Letters were sent to parents of children who received special educational services for those with ASD and who were considered likely to know the target words used in the study and remain undistracted during the task. Nine parents provided informed consent. In addition to parental consent, children also gave oral assent. Participants were told that they were free to take as many breaks as needed and that they could cease participation at any time. One of these children could not complete the tasks, and a follow up interview with the parent of an additional child revealed that the child was re-diagnosed and no longer had a diagnosis of an ASD, and were removed from the sample. The final $ASD_{mainstream}$ sample thus comprised seven male children, six with ASD and one with AS (see Table 1 for descriptive statistics).

[INSERT TABLE 1 HERE]

The remainder of the ASD sample came from private educational centers for children and young adults with ASD. Participants came from three campuses of a single organization that provides day-long Applied Behavior Analysis therapy. As with the $ASD_{mainstream}$ group, youths in the ASD_{center} group were recruited if they were

considered sufficiently verbal to complete the task. Nine parents provided informed consent for their children (n = 8) and young adults for whom they held power of attorney (n = 1), and all participants provided oral assent. Three participants were unable to complete the tasks, leaving a final ASD_{center} sample of six males, three of whom had diagnoses of ASD, one of whom had a diagnosis of AS, one of whom had a diagnosis of HFA, and one of whom had a diagnosis of PDD-NOS. Although symptom severity is less in PDD-NOS than in other ASD subtypes (Witwer & Lecavalier, 2008), the individual with PDD-NOS in the current study did not have the highest verbal ability or NVMA score within the ASD group, supporting his inclusion in the sample. The final ASD sample thus comprised 13 male participants.

Fourteen TD participants were recruited from local schools in the Midwestern USA and word of mouth to participate in the study. Participants were recruited to match the gender and age composition of the ASD group. Data from one participant were omitted due to experimenter error, leaving a final sample of 13 TD participants. The consent and assent procedures were the same as for the ASD group, with the exception of the adult participant who simply provided informed consent.

At the completion of each of the two experimental sessions, participants were provided with a small gift certificate to an online retailer.

Materials and Procedure

Background measures

Verbal ability was estimated using the Peabody Picture Vocabulary Test (PPVT), 4th Edition (Dunn & Dunn, 2007). In order to confirm the cognitive profile of ASD, non-verbal mental age (NVMA) was estimated using Raven's Standard Progressive Matrices (RSPM, Raven, Raven, & Court, 2003).

Metaphor, baseline, and definition tasks

Metaphor comprehension was measured using a computer-based task. Prior to completing the *metaphor* task, all participants completed the *baseline* task. The metaphor and baseline tasks were presented on a 21-inch computer monitor. The screen was covered by a touch screen that enabled participants to answer questions by touching relevant images on the screen.

The baseline task (adapted from [redacted for blinding], in preparation) introduced participants to the nature of the task and response mechanism. Before beginning, the experimenter gave participants three instructions. First, participants were told that, prior to each trial, they would see a smiley face on the screen. They were told that

they could take breaks whenever they saw the smiley face, but when they were ready to begin a trial, they should touch the face and the trial would begin. Second, they were told that they would be asked a question about the story and that they were to indicate their answers by touching the screen. Third, participants were told that after this question, they would be asked a yes-or-no question about the story, and that they were to press the green circle to answer *yes*, and the red circle to answer *no*.

In each of the five baseline trials (order randomized) in the baseline task, participants heard a five-sentence story (M_{words} = 45.4, SD = 1.5) read aloud by a male actor and accompanied by two simple black and white illustrations of the story events. Stories in the baseline task did not include metaphors and thus enabled a comparison between the ASD and TD groups to see if they differ in ability to comprehend stories presented in a computer task (see Figure 1).

[INSERT FIGURE 1 HERE]

After the story, a question mark appeared on the screen while participants were presented with a probe question that tested their comprehension of a specific element of the story. Three pictures then appeared in a horizontal row on the screen (order randomized): a picture depicting the correct answer, an picture depicting an image from the story but which did not correctly answer the question, and a distractor picture not from the story. Participants indicated their response by touching one of the images, which was automatically recorded by the experimental software interpreting the input from the touch screen. After participants answered the *comprehension question*, they heard a *memory question*, which asked a simple factual yes-no question about information presented in one of the first two sentences of the story, such as the location of the characters in the story. While this question was read aloud, participants would see a question mark on the screen, and when the question was over, they would see the green and red circles that they would press to indicate the answer. For any given participant, whether the correct answer was yes or no would be split three to two (counterbalanced). The on-screen location of the correct response image was randomized.

The metaphor task was divided into two experimental sessions. In each session, participants completed ten trials, each of which presented a story that was concluded by a statement that included a primary conceptual metaphor. The ten primary conceptual metaphors were selected from a list provided by Lakoff and Johnson (1999, pp. 50-54, see Table 2).

[INSERT TABLE 2 HERE]

For each primary metaphor, two five-sentence stories were created. The two stories had parallel structures such that the content in each sentence of one version was mirrored in the second version (see Figure 2).

[INSERT FIGURE 2 HERE]

The only systematic difference was that the gender of the characters in one version was opposite to those in the other version. The final sentence of each story contained either a lexicalized version of a primary conceptual metaphor (e.g., "now I *see* it!" for *SEEING IS KNOWING*) or a novel version of the same conceptual mapping (e.g., "now I *view* it!"). Participants would see one story version paired with a lexicalized metaphor in one experimental session, and the other version paired with a novel metaphor in the other session. (The pairing of story version with metaphor type was counterbalanced across participants.) After hearing the metaphoric utterance (either the lexicalized or novel metaphor), participants would be asked which picture shows what the target utterance meant while a question mark was displayed on the screen. They would then see three images in a horizontal array: a *metaphoric* image depicting a metaphoric interpretation of the target utterance, a *literal* image depicting a literal interpretation of the target utterance, and a *distractor* image depicting an object from the story but unrelated to the target utterance. The purpose of the metaphor question was to ensure that participants understood the story and target question. Due to the known effect of context on metaphor processing in ASD (Giora et al., 2012), the stories were constructed in an attempt to make the metaphoric and literal answers supported by context. For example, the metaphoric statement in the *KNOWING IS SEEING* stories—"now I see it!"—came after the character had visual access to an instructive demonstration, thus lending plausibility to an interpretation of the sentence as referring to the visual experience.

The set of metaphor task trials for the first session was created by randomly ordering the ten conceptual metaphors. Twelve unique orders were created. Which version of each conceptual metaphor story was presented on the first day of a given order was randomized with the constraint that, collapsing across all participants, each story version was paired with each metaphor type with equal frequency. The order of stories concluding with each metaphor type (lexicalized vs. novel) was also randomized in the first session, with three constraints: each session included five lexicalized and five novel trials, half of the orders began with a lexicalized metaphor and half with a novel metaphor, and a given metaphor type was not presented more than twice in a row. In other words, in each session half of the participants started with a novel trial and half with a lexicalized trial, and in each session participants completed five lexicalized and five novel trials and never had more than two of either type in a row. The set of trials for the second session was made in the same manner, with the exception that the pairing of metaphor

type to metaphor story was set to be the opposite as the first session so that each participant completed a lexicalized and a novel trial, each within a different story, for each conceptual metaphor.

At the completion of the second experimental session, all participants completed the *definition* task in which they demonstrated an understanding of the target words used in the metaphorical utterances. In this task, participants were read each of the 20 lexicalized and novel target words and asked what the word meant. All participants were able to provide literal definitions, examples, or thematically-related answers to the words.

To summarize, the methodology provided four separate features designed to ensure participants' understanding of the metaphor trials. The first was the baseline task, which was designed to test ability to understand the story format and the requested responses. The next three features were all aimed at testing whether or not participants understood the specific story and probe language on a given metaphor trial. The second feature was the inclusion of a distractor item. The presence of a distractor is the most powerful of the features in that it is present during participants' responses during the response to the metaphor trial. If they did not understand the story and/or probe language, they should choose between the three answer images with equal frequency. The third feature was the definition task. This task was designed to test if participants knew the definition of the words involved in the metaphor so that failure to understand novel metaphors would not be misattributed to a lack of conceptual knowledge. The fourth feature was the memory question. This question was designed to test to see if participants were attending to details in the beginning of the story. Memory questions did not, however, provide information about story details specifically related to the metaphor itself. Later analyses of responses on the memory questions suggested that they were too difficult; both the TD and ASD groups frequently got these questions wrong, despite the fact that performance on the metaphor task did not vary as a function of performance on the memory question. Given the questionable validity of those questions, we do not discuss them further. (All analyses reported below were also ran by taking performance on memory questions into account. None of the results changed in these analyses.)

All tasks were presented in a fixed order across the two sessions, held roughly one week apart, and completed either in a quiet room at the child's school or at the university. The first session began with the baseline task, followed by the first part of the metaphor task, and concluded with the PPVT. The second session began with the remainder of the metaphor task, followed by the definition task, and concluded with the RSPM.

Results

Baseline Phase

Performance in the baseline phase was examined to see if the ASD group was less able to follow stories than the TD group. This question was tested with a univariate analysis of covariance with the number of correct answers out of five trials as the dependent variable, group (TD vs. ASD) as the independent variable, and verbal ability (raw PPVT scores) as the covariate. This test found that after controlling for the significant effect of verbal ability ($F(1,23) = 14.01$, $p < .005$, $\eta_p^2 = .38$), the number of correct answers did not differ between the TD group ($M = 5.0$, $SD = 0.0$) and the ASD group ($M = 4.62$, $SD = .65$), $F < 1$, *ns*. Thus, it appears that verbal ability is a significant predictor of ability to follow stories presented in the current study, but the overall effect is small (nine ASD participants were correct on all five trials, three ASD participants were correct on four trials, and one was correct on three trials) and would be unlikely to explain any group differences in the metaphor task.

Research Questions

1) What underlying factors (i.e., chronological age, verbal ability, or non-verbal mental age) predict metaphor comprehension?

2) Do TD youth understand lexicalized and novel primary conceptual metaphors equally well?

3) Do youth with ASD show similar patterns as TD youth?

The first three research questions were jointly investigated with a multivariate analysis of covariance (MANCOVA) with performance on lexicalized and novel trials as the two dependent variables.

4) Regardless of group differences, do youth with ASD show above-chance levels of metaphor comprehension? Chance responding would result in the selection of the three test images at equal rate; we thus used *t*-tests against chance responding (33%) to investigate whether or not participants chose images at chance.

Background Measures

Youths in the $ASD_{mainstream}$ group were compared to the ASD_{center} group to see if they differed in demographic characteristics or background measures. The groups did not differ in chronological age ($t(11) < 1$, *ns*; see Table 1 for descriptive statistics), verbal ability ($t(11) < 1$, *ns*), or NVMA ($t(9) < 1.3$, *ns*), supporting the decision to collapse them into a single ASD group.

As expected, TD participants had significantly higher verbal ability than did participants in the ASD group ($t(24) = 4.96$, $p < .001$). There was no difference in chronological age ($t < 1$, *ns*). TD participants had marginally

higher NVMA than did participants in the ASD group, equal variances not assumed ($t(13.99) = 2.06$, $p < .06$), but that result must be interpreted with caution. One participant in the $ASD_{mainstream}$ group was unable to complete the NVMA task, another was unable to be scheduled for the second session in which the NVMA task was administered, and experimenters reported several instances in which ASD participants became fatigued and completed the answer sheet without looking at all of the patterns or answer options. There are therefore reasons to doubt the validity of NVMA scores in the ASD group. Given that the primary purpose of the NVMA measure was to confirm functionality differences between the TD and ASD groups, that previous research has not found links between NVMA and metaphor comprehension (e.g., Rundblad & Annaz, 2010b), and the uneven completion of this task between TD and ASD groups, NVMA will not be included in hypothesis tests.

Analyses of Research Questions

Questions 1, 2, and 3: Do TD youth understand lexicalized and novel primary conceptual metaphors equally well, do youth with ASD show similar patterns as TD youth, and what underlying factors predict performance?

Preliminary analyses revealed that chronological age did not predict comprehension of either lexicalized or novel metaphors for either the TD or ASD groups (all Fs < 1.06, all ps > .32), therefore, further analyses did not include chronological age. Preliminary analyses with group (ASD vs. TD) and verbal ability as predictors found a marginally significant effect of verbal ability ($F(2,22) = 2.98$, $p < .08$, $\eta_p^2 = .21$). Given the effect size and the narrow margin by which verbal ability missed being significant, verbal ability was kept in the final model and is reported below. The percentage of trials which participants completed by selecting the metaphorical match image on lexicalized and novel trials was correlated $r(24) = .91$, $p < .001$; therefore, the data were analyzed using (MANCOVA), with percentage of lexicalized and novel trials answered with the metaphoric image as the two dependent variables, group (TD vs. ASD) as the fixed factor, and verbal ability (raw scores on the PPVT) as the covariate.

There was a significant difference between the TD and ASD groups on the linear combination of the dependent variables, $F(2,22) = 4.47$, $p < .05$, Wilk's $\lambda = .71$. Univariate ANOVAs with Bonferroni corrections were used to investigate the effect of group (TD vs. ASD) on each dependent variable independently. On trials concluding with lexicalized metaphors, TD participants selected the metaphoric match on significantly more trials than did ASD participants with ASD, $F(1,23) = 7.02$, $p < .025$, $\eta_p^2 = .23$ (see Table 3 for descriptive statistics).

[INSERT TABLE 3 HERE]

On trials concluding with novel metaphors, TD participants selected the metaphoric match on significantly more trials than did participants with ASD, $F(1,23) = 6.39$, $p < .025$, $\eta_p^2 = .22$.

The omnibus MANCOVA revealed that the effect of verbal ability approached significance, $F(2,22) = 2.98$, $p < .08$, Wilk's $\lambda = .79$. Although this test did not reach the canonical level of .05, we chose to investigate the effect of verbal ability further using univariate ANCOVAs with Bonferroni corrections. Although caution must be exercised when interpreting these tests, we report them because of the important role of verbal ability in some theoretical approaches to metaphor interpretation (e.g., the graded salience hypothesis, Giora, 1997; 2003),and the small margin by which it missed the cut-off. Due to the lack of any interactions between verbal ability and group in the ANCOVAs (Fs < 1, *ns*), theses analyses collapsed across group. Verbal ability was not a significant predictor of performance on lexicalized trials ($F < 1$, *ns*). In contrast, verbal ability predicted performance on novel trials at near-significant levels after correcting for multiple comparisons using a Bonferroni correction, $F(1,23) = 5.64$, $p = .026$, $\eta_p^2 = .20$).

Finally, a repeated measures ANOVA with metaphor type (novel vs. lexicalized) as the within subjects factor and group (TD vs. ASD) as the between subjects factor was used to examine whether or not metaphoric images were selected at different proportions following lexicalized or novel metaphors. The main effect of metaphor type was not significant, $F(1,24) = 1.55$, $p > .05$, $\eta_p^2 = .06$. The interaction between group and metaphor type was likewise not significant, $F(1,24) = 1.42$, $p > .05$, $\eta_p^2 = .06$. These results thus support the prediction made by CMT that both TD youth (cf. Özçalışkan, 2005) and those with ASD should comprehend novel linguistic formulations of conceptual metaphors as readily as lexicalized formulations.

Question 4: Do youth with ASD show above-chance levels of metaphor comprehension?

Although participants in the ASD sample generally underperformed TD participants, these analyses do not address the question of whether or not the two groups were able to comprehend primary conceptual metaphors. One-sample *t*-tests against chance responding (33%) revealed that participants in the ASD sample responded to both lexicalized and novel conceptual metaphors with above-chance selection of metaphoric images and below-chance selection of distractor images (all ps < .005, see Table 3 for descriptives). On both trial types, selection of images depicting a literal interpretation of the probe sentence did not differ from chance. In comparison, TD participants selected these metaphoric images at above-chance levels on both lexicalized and novel trials, and selected both the literal and distractor images at below-chance levels on lexicalized and novel trials (all ps < .001).

Another way of describing the below-chance selection of distractor images is that participants chose story-relevant (i.e., metaphorical and literal) responses at above-chance levels. This interpretation begs the question: if participants were usually selecting between the two story-relevant options, did they have a significant preference for either metaphorical or literal options? For TD participants, the tests against chance answer this question; metaphoric responses were significantly above chance and literal responses were significantly below chance, demonstrating that TD youths overwhelmingly interpreted both the lexicalized and novel metaphors as, indeed, metaphoric utterances.

While for ASD participants metaphoric responses were significantly above chance and literal responses were not different from chance, it is important to note that these tests do not imply that ASD participants chose the two responses at significantly different rates (Gelman & Stern, 2006). Therefore, the literal response rate was subtracted from the metaphor response rate for each participant across both metaphor types, and these *difference* variables were analyzed with one-sample *t*-tests. If participants selected story-relevant images at chance levels, this difference variable should equal zero. If, however, participants chose metaphoric images more than literal images, then this difference variable should be greater than zero. This was the case for lexicalized trials; ASD participants chose metaphoric images significantly more than literal images, $t(12) = 3.15$, $p < .01$. For novel trials, the difference was descriptively in the same direction, although it was not significant, $t(12) = 1.69$, $p < .12$. Combined with the earlier analyses, it seems that ASD participants understood the metaphoric image as relevant to the story, but only demonstrated a reliable preference for the metaphoric interpretation over the literal interpretation on lexicalized metaphors.

Although the tests of verbal ability and NVMA did not find any differences between the two ASD groups, and therefore do not support inferential tests comparing them directly, we nonetheless noticed that the $ASD_{mainstream}$ group might have driven the patterns in the *t*-tests against chance. Participants in the $ASD_{mainstream}$ group chose the metaphoric image at significantly higher proportions than the literal image on lexicalized trials (73.5% metaphoric, 21.9% literal, $t(6) = 5.15$, $p < .005$) and descriptively higher levels on novel trials (63.5% metaphoric, 31.9% literal, $t(6) = 2.12$, $p < .08$). Participants in the ASD_{center} group, on the other hand, did not chose metaphoric and literal images at different proportions for either lexicalized trials (48.7% metaphoric, 42.0% literal, $p > .76$) or novel trials (41.2% metaphoric, 43.2% literal, $p > .59$).

Discussion

The current study investigated primary conceptual metaphor comprehension in typically developing (TD) individuals and individuals with autism spectrum disorder (ASD). Conceptual metaphor theory (CMT, Lakoff & Johnson, 1980; 1999) proposes that many abstract concepts are structured by sensorimotor experiences early in life. For example, the experience of walking toward a goal state leads to links between the experience of reaching a destination and the more abstract concept of *purpose*, and this conceptual linkage—called a primary conceptual metaphor (Grady, 1999)—underlies our understanding of verbal metaphors that describe purposes in terms of destinations, such as a professor who has recently been granted tenure referring to *reaching the promised land*. Because CMT posits that these verbal metaphors are understood by accessing the metaphorically structured concept rather than relying on pragmatic skills that are known to be impaired in ASD (Tager-Flusberg, 2003), CMT makes a unique prediction that individuals with ASD should be able to understand both lexicalized and novel conceptual metaphors. Consistent with these predictions, both TD and ASD individuals in the current study understood lexicalized and novel formulations of conceptual metaphors, although it is important to note that the ASD sample underperformed the TD sample. Despite the differences between TD and ASD participants, these findings provide the first evidence to our knowledge of reliably above-chance performance on a set of novel metaphors in individuals with a range of ASD diagnoses and thus provide compelling evidence of true metaphoric competence in youth with the disorder.

This finding of above-chance performance on trials of both metaphor types supports the prediction made by CMT that individuals with ASD form mappings between concepts related to sensorimotor experience and abstract concepts that are activated along with those experiences. In particular, the lack of a difference between performance on lexicalized trials and novel trials provides strong support for CMT, which claims that both are understood through similar mechanisms. With one notable exception (Giora et al., 2012, discussed below), individuals with ASD have repeatedly shown severe deficits in metaphor comprehension. The current study was not designed to test the interpretive processes used during metaphor comprehension, but strong performance on all metaphor types in the current study lends support to the argument, made by CMT, that metaphors based on conceptual mappings are understood by activating the underlying mapping. This is not to say that the structure of these mappings or the use of these mappings to interpret verbal metaphors are the same in youth with ASD as in TD youth. To the contrary, performance in the ASD group revealed less metaphor comprehension than the TD group. It is possible that this

discrepancy is caused by general deficits in embodied cognition in ASD (Eigsti, 2013) due, in part, to differences in brain connectivity (Belmonte et al., 2004; Just et al., 2007) that may result in different and/or delayed conceptual mappings between sensorimotor and abstract concepts (De Jaegher, 2013). Prior research linking the connectivity differences to deficits in comprehending sentences involving visual imagery (Kana, Keller, Cherkassky, Minshew, & Just, 2006) lends support to the argument that these connectivity differences may, at the very least, impact the ability of individuals with autism to understand verbally presented conceptual metaphors.

The most compelling support for CMT in the current study is the finding that youths with ASD understood novel formulations of conceptual metaphor, but this study was not the first to find novel metaphor comprehension in ASD. Giora and colleagues (2012) found that individuals with Asperger's syndrome (AS) were able to interpret familiar metaphors and that, with a supportive context, they were also able to understand novel metaphors. Nevertheless, several features of the current study make the performance of the ASD sample on novel metaphors more impressive. First, the ASD sample in the current study had lower verbal ability than the TD sample, unlike the AS sample in Giora and colleagues' sample. Second, the current study included youths as young as six-years-old, and we did not find evidence of improved performance on either lexicalized or novel primary conceptual metaphors with increasing chronological age (in contrast to research investigating traditional metaphor, Rundblad & Annaz, 2010a). Third, the task in the current study could be interpreted as more demanding; whereas participants in Giora and colleagues' research simply had to make yes-no meaningfulness judgments about metaphorical utterances, participants in the current had to demonstrate a preference for metaphoric interpretations over plausible literal interpretations. Despite these three differences, the rate of metaphoric understanding of novel metaphors in supportive contexts by the AS sample in Giora and colleagues' research was closer to chance (56.2% with chance responding of 50%) than the ASD metaphoric understanding rate in the current study (53% with chance responding of 33%). The most plausible explanation of the impressive performance of the ASD sample in the current study is that they were tested on primary conceptual metaphors and were thus able to capitalize on extant conceptual mappings to aid their comprehension. In other words, these metaphoric mappings within the conceptual system may be the early building blocks of metaphoric competence in ASD that the current study was designed to find. Additionally, although individuals with ASD have differences in embodied cognition (De Jaegher, 2013; Eigsti, 2013) that may have contributed to the lower metaphor interpretation rates of the ASD sample than the TD sample in the current study, the ability to comprehend primary conceptual metaphors remained intact.

The fact that Giora and colleagues' data supported the graded salience hypothesis (GSH, Giora, 1997; 1999; 2003), an influential theory that posits a single mechanism for the interpretation of literal and nonliteral statements, begs the question of whether or not the findings of the current study can also be explained by this framework. GSH argues that literal and nonliteral language processing are similarly guided by a sensitivity to context that aids in the selection of the most salient meaning for a given utterance. Giora and colleagues (2012) account for the differences in metaphor comprehension by noting that "people with AS may, on average, experience less or more narrow social interactions and thus be less exposed to verbal stimuli compared to typically developing (TD) individuals" (p. 25). This reduced exposure would negatively affect the development of polysemous word meanings which would, in turn, give an individual with AS fewer familiar meanings from which to choose in a given context even though the underlying processes operate similarly in both individuals with AS and TD individuals. Thus, GSH makes the prediction that semantic competence should predict performance, especially on lexicalized metaphors. The measure of verbal ability used in the current study, the PPVT, is not a perfect measure to test this hypothesis as it measures semantic breadth more than the number of polysemous word meanings, which is more important for GSH. However, research has found that the PPVT is valid proxy measurement for polysemy (Miller & Lee, 1993), thus allowing some tentative conclusions. The prediction made by GSH that verbal ability should predict performance on lexicalized trials was not supported for either the TD or ASD groups. Similarly, because lexicalized metaphors, by definition, rely on polysemous word knowledge for comprehension and novel metaphors do not (or at least do to a lesser degree), GSH predicts better performance on lexicalized metaphors than novel metaphors. Indeed, Giora and colleagues (2012) repeatedly found that for both AS and TD groups, familiar items were understood better than novel items. Once again, that prediction was not supported in the current study; both the TD and ASD samples did not show different rates of comprehension of lexicalized and novel metaphors.

Although the current findings provide strong support for CMT and not GSH, it does not necessarily follow that these findings are evidence *against* GSH. The differences between the current study and Giora et al. (2012) could be explained if GSH could tailor its predictions to the type of metaphor being interpreted. The strength of GSH is its parsimony; it posits a single processing mechanism for selecting among multiple meanings encoded in the mental lexicon, regardless of the literality of those meanings. However, the current study may suggest that in addition to choosing among meanings coded in the mental lexicon, the mechanisms that contribute to selecting more salient meanings can choose between conceptual mappings. Therefore, even though novel metaphors do not, by

definition, have the metaphoric meanings coded in the mental lexicon, they could still be the most salient meanings in a given context if those meanings are represented in conceptual metaphors. If, as the current study and previous research with TD adults (Gibbs, 2011) suggests, some metaphors exist within the conceptual system, then it could be possible that some metaphorical meanings could achieve salience not through language learning and understanding of context, but rather by underlying conceptual mappings. In other words, rather than looking simply to the coding of meanings within the mental lexicon to determine salience, individuals may be able to use contexts to access conceptual mappings and have these meanings compete with coded meanings for salience.

Limitations and Future Directions

One key limitation of the current study is that it did not follow participants longitudinally, limiting its ability to investigate the development of metaphoric competence. The current study was designed to assess comprehension of primary conceptual metaphors, and thus did not employ a longitudinal design. A future study focused on developmental processes would add important information to the findings of the current study; although chronological age did not predict change in metaphoric competence in either the TD or ASD samples, a longitudinal design—especially one including younger children—would be necessary to assess developmental change. A longitudinal design would also be necessary to confirm the suggestive findings of a predictive effect of verbal ability on novel metaphor comprehension.

A second limitation of the current research was the relatively small number of participants. Although the number of ASD participants is similar to other studies in this literature (e.g., Dennis et al., 2001; Rundblad & Annaz, 2010a), a larger number of participants would yield tests that are more sensitive to developmental trajectories. Future studies with larger samples would also be able to capitalize on the use of diagnostic measures such as the Autism Diagnostic Interview (Le Couteur, Lord, & Rutter, 2003) to investigate research questions that were beyond the scope of this study, such as the effect of ASD severity on metaphoric competence (Hus & Lord, 2013).

A fruitful direction for future research would be to focus on adults with ASD; research on adult populations would help address the question of whether or not the performance differences of the ASD group compared to the TD group in the current study was due to truly deficient metaphoric competence or simply delayed performance. The results in the current study suggest that if youth with ASD have the building blocks for comprehension of conceptual metaphors that, with sufficient exposure, they may be able to achieve TD-like adult levels of comprehension. Future studies with adult samples would be useful in testing this prediction. The underperformance

of the ASD group in the current study did not confirm the prediction made by CMT that performance should not differ between the groups. However, if future studies with larger samples of adults with ASD were to find that they perform similarly to TD adults, it would suggest that the predictions made by CMT were correct and that the sample in the current study was not sufficiently constructed to test it. In addition, a larger study could investigate predictions made by GSH; namely, whether or not measures of communicative competence predict performance on conceptual metaphors. Do different kinds of experiences and different kinds of social and linguistic competence predict comprehension of different kinds of metaphors?

Future studies should expand on the kinds of metaphors individuals with ASD can comprehend. According to CMT, *compound* conceptual metaphors exist in conceptual structure like primary conceptual metaphors, but rather than arising from experience, they arise via combinations of multiple primary conceptual metaphors (Grady, 1997b; 1999; Lakoff & Johnson, 1999). For example, the metaphor "*the debater* demolished *my argument*" reflects the compound conceptual metaphor *THEORIES ARE BUILDINGS* (Grady, 1997b), which arises through the combination of two primary conceptual metaphors: *ORGANIZATION IS PHYSICAL STRUCTURE* (created when children build structures by organizing component parts) and *PERSISTING IS REMAINING ERECT* (created when children note that these structures cease to exist when knocked over). The results of the current study that youths with ASD can understand primary conceptual metaphors begs the question of whether or not they can also understand compound conceptual metaphors.

In order to best compare the results from the current study to the extant literature on metaphor comprehension in both TD and ASD samples, future studies should directly compare comprehension of traditional and conceptual metaphors within a single study. A comparison of the current study to other studies, especially those with participants with ASD, suggests that primary conceptual metaphors are comprehended more readily than traditional metaphors. However, differences in methodology could account for some of those differences, which makes a direct test of traditional and conceptual metaphors within a given study an important direction for future research. Another aspect in which future research could enable better comparisons to the extant literature is to use written materials. This would have the additional benefit of allowing some individuals with ASD who perform better on written tasks than auditory tasks to demonstrate metaphor comprehension.

Finally, future studies on metaphor comprehension should investigate languages other than English. Although linguists have analyzed common conceptual metaphors in some languages other than English (see

Kövecses, 2005, for a review), empirical work on comprehension of conceptual metaphors has been greatly dominated by studies in English (but see Giora et al., 2012, for studies in Hebrew; and Özçalışkan, 2005; and 2007, for studies in Turkish). CMT does not predict cross-linguistic differences in primary metaphor comprehension, but those predictions should be examined in future research.

The current research carries exciting potential applications. Although the findings need to be replicated before contemplating modification of educational practices, the current findings point to some potential strategies. First, if primary conceptual metaphors are indeed the building blocks of metaphoric competence as suggested by this study, then educators could begin lessons on metaphoric language with these mappings, as they are most likely to be understood by individuals who are younger or who have more severe symptoms. Second, extensions of these findings have the potential to shape the education of figurative language in dramatic ways. Lakoff and Turner (1989) analyzed many poetic metaphors encountered in works of literature and poetry and broke them down into component conceptual metaphors. If future research confirms that youth with ASD understand both primary and compound conceptual metaphors, it could provide educators of ASD youth tools they could use to instruct children how to comprehend metaphors in conversation and literature.

Footnotes

[1] Although the current version of the Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 2000) longer contains the diagnosis of Asperger's syndrome, instead folding the diagnoses under the umbrella diagnosis of ASD (American Psychiatric Association, 2013b), we will use the term here in the interest of accurately summarizing the extant literature.

[2] We use the term *traditional* metaphor to refer to non-conceptual metaphors (but see Lakoff & Turner, 1989; and Lakoff & Johnson, 1999, for arguments that most traditional metaphors are based in conceptual mappings).

[3] Conceptual metaphors are customarily expressed in italicized capital letters.

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Figure Captions

Figure 1. Example of a baseline trial script, images, probe question, and answer options

Figure 2. Example of novel and lexicalized metaphor stories generated from the same conceptual metaphor, including scripts, images, probe questions, and answer options

Table 1. Background measures descriptive statistics

Table 2. Primary conceptual metaphors, with novel and lexicalized probes, used in the metaphor task

Table 3. Descriptive statistics for performance on metaphor task

Figure 1
Click here to download Figure: ConceptualMetaphorInASD - Figure 1.doc

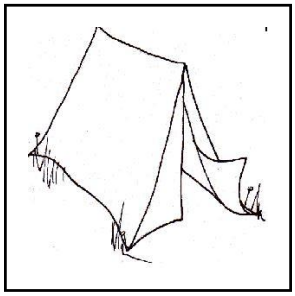
Fig. 1

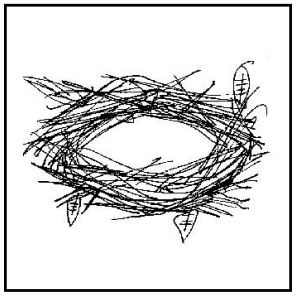
Example of a baseline trial script, images, probe question, and answer options

Story and probe question

Story	Image on screen
Mary goes camping with her parents. *They have a big tent to sleep in.*	
Today, Mary and her parents go for a walk. *On the walk, they see a bird sleeping in a nest.* *After the walk, Mary says, "I'm going to go to sleep now."*	
Probe: *Where is Mary going to sleep?*	?

Answer options (location randomized)


[Correct]


[Story-relevant but incorrect]

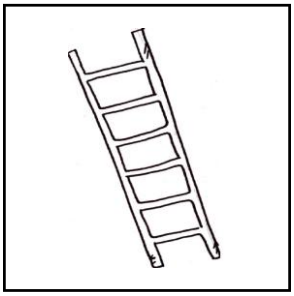

[Distractor]

Figure 2
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Fig. 2

Example of novel and lexicalized metaphor stories generated from the same conceptual metaphor, including scripts, images, probe questions, and answer options

Two story versions for *KNOWING IS SEEING* and probe questions

Story Version 1, with novel metaphor	Image on screen	Story Version 2, with lexicalized metaphor	Image on screen
Kristin is trying to make cookies. *She doesn't know how to make them.* *Her cookie dough looks wrong.*		*Austin is trying to make a sand castle.* *He can't make one.* *The sand won't stay in place.*	
Her mom teaches her how to make the dough. *Kristin says,"now I <u>view</u> it!"*		*His mom shows him how to make sand castles.* *Austin says,"now I <u>see</u> it!"*	
Probe: *Which picture shows what "now I <u>view</u> it" means?*	?	**Probe**: *Which picture shows what "now I <u>see</u> it" means?*	?

Answer options for Version 1 (location randomized)


[Metaphor]


[Literal]


[Distractor]

Answer options for Version 2 (location randomized)


[Metaphor]


[Literal]


[Distractor]

Table 1

Background measures descriptive statistics

Group (sample size)	Statistic	CA (months)	PPVT	RSPM
TD (*n*=13)	M	153.2	190.0	46.0
	SD	51.7	20.9	7.3
	Min	83	153	32
	Max	259	220	55
ASD (*n*=13; *n*=11 on RSPM)	M	155.4	136.3**	35.9†
	SD	51.9	33.0	14.8
	Min	87	90	15
	Max	267	183	56

CA=chronological age; PPVT=Peabody Picture Vocabulary Test; RSPM=Raven's Standard Progressive Matrices
Difference from TD: **($p < .001$), †($p < .06$)

Table 2

Primary conceptual metaphors, with novel and lexicalized probes, used in the metaphor task

Primary conceptual metaphor	Lexicalized probe	Novel probe
AFFECTION IS WARMTH	*Warm*	*Toasty*
AIDS TO ACTION ARE AIDS TO MOTION	*Rough*	*Jagged*
BAD IS STINKY	*Stinks*	*Smells rotten*
CAUSES ARE PHYSICAL FORCES	*Push*	*Shove*
DIFFICULTIES ARE BURDENS	*Weight on my back*	*Stone on my shoulders*
HAPPY IS UP	*Down*	*Flattened*
IMPORTANT IS BIG	*Big*	*Gigantic*
KNOWING IS SEEING	*See*	*View*
PURPOSES ARE DESTINATIONS	*I'm not there*	*I haven't arrived*
SIMILARITY IS CLOSENESS	*Close*	*Near*

Table 3
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Table 3

Descriptive statistics for performance on metaphor task

		Lexicalized Trials				Novel Trials			
Group	Statistic	%Metaphor	%Literal	%Distractor	Difference	%Metaphor	%Literal	%Distractor	Difference
TD (*n*=13)	*M*	0.90	0.06	0.04	0.85	0.90	0.07	0.03	0.83
	SD	0.12	0.09	0.07	0.20	0.12	0.09	0.07	0.20
	Min	0.6	0	0	0.3	0.63	0	0	0.5
	Max	1	0.3	0.22	1	1	0.25	0.25	1
ASD (*n*=13)	*M*	0.62	0.31	0.07	0.31	0.53	0.37	0.10	0.16
	SD	0.21	0.15	0.11	0.35	0.21	0.17	0.16	0.34
	Min	0.22	0	0	-0.33	0.22	0.1	0	-0.33
	Max	1	0.67	0.33	1	0.9	0.67	0.5	0.8
Total	*M*	0.76	0.18	0.05	0.58	0.72	0.22	0.06	0.50
	SD	0.22	0.18	0.09	0.39	0.25	0.20	0.13	0.44
	Min	0.22	0	0	-0.33	0.22	0	0	-0.33
	Max	1	0.67	0.33	1	1	0.67	0.5	1

Difference=Percentage of metaphor responses minus percentage of literal responses

*Author Note

Eric L. Olofson, Drew Casey, Olufemi A. Oluyedun, and Adam Becerra: Wabash College, 301 W Wabash Ave, Crawfordsville, IN 47933, USA. Jo Van Herwegen: Kingston University, Penrhyn Road, Kingston upon Thames, Surrey KT1 2EE, UK. Gabriella Rundblad: King's College London, FWB – WBW, Waterloo Road, London SE1 9NH, UK.

Olufemi A. Oluyedun is now at Michigan State University, 426 Auditorium Rd, East Lansing, MI 48824, USA. Adam Becerra is now at the Adler School of Professional Psychology, 17 N Dearborn St., Chicago, IL 60602, USA.

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Correspondence concerning this article should be addressed to Eric Olofson, Wabash College, 301 W Wabash Ave, Crawfordsville, IN 47933, USA, 1-765-361-6328, olofsone@wabash.edu.

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